

**Supplemental Specification
2005 Standard Specification Book**

SECTION 02892

TRAFFIC SIGNAL

Delete Section 02892 in its entirety and replace with the following:

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Materials and procedures for installing traffic signals.
- B. Materials and procedures for installing traffic counting loop detectors.

1.2 RELATED SECTIONS

- A. Section 02466: Drilled Caisson
- B. Section 02741: Hot Mix Asphalt (HMA)
- C. Section 02748: Prime Coat/Tack Coat
- D. Section 02891: Traffic Signs
- E. Section 03055: Portland Cement Concrete
- F. Section 03211: Reinforcing Steel and Welded Wire
- G. Section 03310: Structural Concrete
- H. Section 03575: Flowable Fill

1.3 REFERENCES

- A. ASTM A 123: Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- B. ASTM A 307: Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
- C. ASTM A 325: Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength

- D. ASTM A 570: Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
- E. ASTM B 85: Aluminum-Alloy Die Castings
- F. ASTM B 766: Electrodeposited Coatings of Cadmium
- G. ASTM D 638: Tensile Properties of Plastic
- H. ASTM D 2240: Rubber Property-Durometer Hardness
- I. ASTM D 3005: Low-Temperature Resistant Vinyl Chloride Plastic
Pressure-Sensitive Electrical Insulating Tape
- J. ASTM F 1554: Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-
ksi Yield Strength
- K. American Iron and Steel Institute (AISI)
- L. American National Standards Institute (ANSI)
- M. American Wire Gauge (AWG)
- N. Electric Utility Service Equipment Requirements Committee (EUSERC)
- O. International Municipal Signal Association (IMSA) Standards
- P. National Electrical Code (NEC)
- Q. National Electrical Manufacturers Association (NEMA)
- R. Pedestrian Traffic Control Signal Indicator (PTCSI) Standards
- S. Rural Electrical Association (REA) Bulletin
- T. Underwriters Laboratory (UL)
- U. Vehicle Traffic Control Signal Head (VTCSH) Standards
- V. 3M - 8982/Gel

1.4 SUBMITTALS

- A. Certified test report of wire compliance as specified. IMSA 20-1, 50-2, 51-1, 51-3, 51-5, 51-7, 60-6.
- B. Submit samples of materials for approval when requested.
- C. Submit two copies of the following within 15 days after receiving notice to proceed:
 - 1. List of equipment and materials (name of manufacturer, size, and identification number).
 - 2. Detailed shop drawing, wiring diagrams, and certifications.
 - 3. Manufacturers' warranties, guarantees, instruction sheets, and parts lists.
- D. Submit UDOT Vehicle Detector and Street Lighting Splice certifications for all individuals that will perform wiring splices.

1.5 ACCEPTANCE

- A. Signal Warranties and Guarantees
 - 1. The notice of acceptance for traffic signal work is not given until six months after the date of completion of punch list items.
 - 2. During this period, all manufacturer's warranties and guarantees on Contractor-furnished electrical and mechanical equipment are enforced.
 - 3. At the end of the period and after all electrical and mechanical defects within the scope of warranties and guarantees are corrected, the Engineer makes written acceptance of the work completed and relieves the Contractor of further responsibility for that portion of the project.
 - 4. Partial acceptance does not void or alter any terms of the Contract
- B. The six-month warranty period for signal work does not affect the processing of a semi-final estimate when the Contract is 95 percent or more complete, or after completion of work on the project.

C. Detector Loop Circuit: Conduct the following acceptance tests before and after backfill for approval by the Engineer.

1. Measure and report in ohms, the continuity of each loop.
2. Value to be within 5 percent of calculated values.
3. Loop Resistance Formula: $R_t = R_l + R_d$

Where:

- R_t = Resistance of loop as measured at pull box.
 R_l = Resistance of loop lead in wire (from the loop to junction box).
 Equal to 0.002525 ohms per foot, (times 2) measured from loop to pull box splice point.
 R_d = Resistance of Loop = $P \cdot T \cdot R_c$ (See Loop Resistance Table below)
 P = Perimeter of loop in feet
 T = Number of turns in the loop.
 R_c = Resistance of #14 AWG copper wire per foot equals 0.002525 ohms.

Table 1

Loop Resistance			
Loop Type			R_d Loop Resistance (ohms)
Width (ft)	Length (ft)	Turns	
5	6	4	0.22
5	10	4	0.32
6	Circular	4	0.19
6	Circular	5	0.24
6	6	4	0.24
6	10	4	0.32
6	12	4	0.36
6	14	3	0.30
6	16	3	0.33

4. Measure and report each loop's insulation resistance. Minimum acceptable reading measured between the loop conductor and ground is 450 M Ω or greater, when tested with a 500 V megger meter.
5. Measure and report the inductance of each loop. Acceptable inductance readings are greater than 90 μ H for individual loops, and less than 1000 μ H for a 4 loop group.

- D. Signal Power Circuits:
 - 1. Measure and report continuity of bonding conductors by testing between AC+ supply and metal poles: A 1000 Watt load, tested to each pole frame must incur less than 2 Volts drop, measured from the pole to the cabinet neutral conductor.
 - 2. Insulation resistance of supply conductors measured to ground will have not less than 100 MΩ of leakage (500 V megger meter).
- E. Video Detection Circuit: Demonstrate each video detection circuit operates per manufacturer's specifications.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Use electrical components as listed and defined by the NEC.

2.2 SIGNAL POLE AND TRAFFIC SIGNAL LIGHT SUPPORT ARM

- A. Post Mounted Signals Pole:
 - 1. Steel, as specified. ASTM A 570, Grade 33.
Allowable stresses: $F_b = 21,750 \text{ psi } (0.66F_y)$
 $F_v = 10,900 \text{ psi } (0.33 F_y)$
 - 2. Galvanized as specified. ASTM A 123.
 - 3. Wind load: 80 mph wind with 105 mph gusts.
- B. Foundation:
 - 1. Concrete: Class AA(AE) Concrete. Refer to Section 03055.
 - 2. Reinforcing steel: Coated steel. Refer to Section 03211.

2.3 BOLTS, NUTS AND HARDWARE

- A. Anchor Bolts and Nuts:
 - 1. Steel as specified. Signal, CCTV, and Luminaire Poles use ASTM F 1554 Grade 55; Signal Cabinet use ASTM A 307.
 - 2. Zinc-plated or galvanized, as specified.
 - a. Zinc-plated as specified. ASTM B 766.
 - b. Galvanized steel: ASTM A 123.
 - 3. Nuts: Free running by hand for total thread length of bolt.
- B. Slip Bolts as specified.
 - 1. Zinc plated: ASTM B 766.
 - 2. Steel: ASTM A325.

2.4 WIRE

- A. Copper, as specified. International Municipal Signal Association (IMSA)
- B. Size as specified. AWG
- C. Service Cable:
 - 1. Single-conductor, as specified. Types RHH-USE-RHW.
- D. Interconnect cable:
 - 1. Twisted pair filled shielded cable, as specified. IMSA 60-6.
 - 2. Single mode fiber optic cable, as specified.
- E. Signal Cable:
 - 1. Multi-colored cables, as specified. IMSA 20-1
- F. Bonding/Grounding System Wire:
 - 1. Solid, bare, soft-drawn, copper wire, as specified. Sized to meet NEC 250-1.
- G. Detector Lead-In Wire (homerun): as specified. IMSA 50-2.
- H. Detector Loop Wire:
 - 1. PVC Sensor Loop Wire – No. 14, single-conductor, stranded wire as specified. IMSA 51-3.
 - 2. Saw Cut Sensor Loop Wire – No. 14, single-conductor, stranded wire encased in a polyethylene tube as specified. IMSA 51-7.
- I. Commercially Manufactured Preformed Loop:
 - 1. Highly abrasion-resistant alloy cover with high tensile strength braided synthetic fiber reinforcement, max. O.D. of 3/8 inch.
 - 2. Withstand minimum pressure of 1400 psi.
 - 3. Good flexibility over a wide temperature range and rated to withstand the temperatures of an asphalt overlay project.
 - 4. Superior resistance to oil, gasoline, salt, moisture and impact.
 - 5. Loops shall be individually marked as to the direction of the wire turns.
 - 6. Manufacturer to provide minimum 15 year guarantee.
- J. Splice Sealing: Rural Electrical Association (REA) Bulletin 17551-100.
 - 1. Insulate conductors individually and encapsulate with mastic rubber pads and over wrap with vinyl electric tape. Overcoat completed splice with waterproof sealant. ASTM D 3005, Type I or II. UL 510.
- K. Color Coding Tape:
 - 1. Vinyl electric tape, as specified. UL 510.

- L. Video Detection Circuit:
 - 1. Video Detection/Camera Power Circuit Cable: As specified per manufacturer requirements.

2.5 VEHICLE TRAFFIC SIGNAL HEAD

- A. Comply with VTCSH standards. Refer to SL Series Standard Drawings.
- B. Signal Head Assembly:
 - 1. 12-inch vehicular signal head as specified.
 - 2. Separate, interchangeable, and expandable without tie rods.
 - 3. Stainless steel bolts, screws, hinge pins, lugs, and hardware.
 - 4. Die-cast aluminum parts, including the doors, as specified: ASTM B 85. Clean, smooth parts free from flaws, cracks, blowholes, or other imperfections.
 - 5. Perimeter door gasket to provide moisture and dust resistant seal.
 - 6. Mounting hardware for securing LED module to door housing.
 - 7. Integrally round serrated boss openings in the top and bottom of each section that accepts a standard 1.5-inch pipe mounting or universal bracket mounting hardware. Capable of adjusting a full 360 degrees around a vertical axis.
 - 8. 6-position wiring terminal strip.
 - 9. Tunnel visor securely mounted to the door at a minimum of four attachment points.
 - 10. Powder coat all exterior and interior surfaces of the signal housing, door, and outside of visor in Highway Yellow. Inside of visor is painted flat black.
- C. Optical Unit:
 - 1. Mount LED Ball and Arrow Vehicle Signal Module to door housing for unrestricted easy access.
- D. Back Plate:
 - 1. Constructed with minimum 18-gage aluminum.
 - 2. Provide louvered design to reduce wind loading on mast arm structure.
 - 3. Both sides primed and painted flat black.
 - 4. Designed to be attached to the signal head used.

2.6 PEDESTRIAN SIGNAL HEAD

- A. Comply with PTCSI standards. Refer to SL Series Standard Drawings.
- B. Signal Head Assembly:
 - 1. Provide 16-inch by 18-inch housing, swing down door assembly, and LED module.

2. Moisture and dust resistant.
 3. Die cast, single piece aluminum with 1-1/2 inch top and bottom openings, and integrally cast shurlock boss. Use stainless steel screws and assembly hardware.
 4. Swing down door assembly capable of being opened without tools, constructed from single piece aluminum alloy, die cast with two hinge lugs at the bottom and two latch slots at the top of the door. Universal housing with interchangeable castings for hinge and latch hardware is acceptable.
 5. 3-position wiring terminal strip.
 6. Provide electrostatic apply synthetic enamel as specified. Gloss black case and doorframe. Oven-cure finish for a minimum of 20 minutes at 350 degrees F.
- C. Optical Unit:
1. Mount LED Pedestrian Signal and Count Down Pedestrian Signal Modules to door housing for unrestricted easy access.

2.7 PEDESTRIAN BUTTONS

- A. Refer to SL Series Standard Drawings.
- B. Pedestrian Button with LED Indicator
1. Provide pedestrian button with standard 4-bolt circle (2.60-inch +/- 0.05-inch diameter).
 2. Provide ADA compliant assembly with a 2 inch diameter stainless steel actuator, rated for 100 million actuations, requiring between 1 and 3 pounds of force to actuate.
 3. Provide a low-movement (maximum movement of 12/1000 of an inch), pressure activated, tamper-proof, highly vandal resistant button.
 4. Provide assembly with solid state electronic Piezo switch rated for 100 million cycles with no moving plunger or moving electrical contacts.
 5. Provide assembly with internal circuitry with a resetting switch so as to avoid held calls to the signal controller.
 6. Provide assembly with built in surge protection, with all switch electronics sealed within the cast aluminum housing. Enclose all supporting circuitry within the button with wiring to the pushbutton terminated on two screw terminals.
 7. Provide a rain-tight gasket to seal between the button assembly and the frame.
 8. Provide assembly that is designed to prevent water and ice from entering or accumulating on or in the button, and that is capable of protecting the button cap from side impacts.

9. Provide button that gives feedback to the user that a call has been made in both of the following forms:
 - a. Audible beep when button is pushed.
 - b. Momentary LED light as the button is pushed, or LED light stays on for 3-5 seconds if the button is pushed and held closed.
- C. Pedestrian Push Button Frame
 1. Provide cast aluminum frame, powder coated black, capable of supporting push button and a 9 inch x 12 inch sign, with the following characteristics:
 - a. Frame attaches to the pole using two ¼ inch -20 x 1.5-inch hex head brass bolts attached behind the sign.
 - b. Frame is additionally supported using adjustable staves.
 - c. Sign attaches above the button using 8-32 stainless steel Allen-head screws.
 - d. Cable guide extends through a 7/8 inch diameter mounting hole in the support pole to channel wiring to the button.
- D. Pedestrian Push Button Sign
 1. Provide a 9 inch x 12 inch sign with corner radii that allow the sign to fit completely within the frame.
 2. Provide a two-sided R10-4b sign, with one side of the sign with a right arrow and the other side of the sign with a left arrow.
 3. Provide sign fabricated from aluminum substrate using ASTM Type III or higher reflective sheeting (sign Type A1) with standard 8-32 clearance holes or eyelets for mounting.

2.8 LED SIGNAL MODULES

- A. LED Signal Module Standards:
 1. Use new LED vehicle signal modules that meet current VTCSH standards.
 2. Use new LED pedestrian and countdown signal modules that meet current PTCSI standards.
- B. Physical Requirements:
 1. Use modules that fit into traffic signal housing without modification to the housing.
 2. Use retrofit replacement modules that only require removal of the existing optical unit components, i.e., lens, lamp module, gaskets, and reflector.
 3. Watertight and dust resistant module that securely fits the housing door and wire pigtails for direct connection to wiring terminal strip. Screw-in modules are not acceptable.
 4. Provide tinted lens for all LED modules.
 5. Use LED modules that have the appearance of an incandescent traffic signal lens and wide angle viewing capability.

- C. Additional Requirements for Pedestrian Signal Modules:
 - 1. Provide 9-inch countdown numerals when specified.
 - 2. Provide symbol message that blanks out under ambient light conditions when the pedestrian symbols are not active.
 - 3. Provide circuitry that isolates man/hand symbols so they cannot be displayed at the same time.
- D. Manufacturer Warranty:
 - 1. Provide the following minimum warranty provisions:
 - a. Replace or repair module if it fails to function as intended due to workmanship or material defects within the first 84 months from the date of delivery. If repaired, the warranty covers all parts and labor necessary or incidental to the repair.
 - b. Provide all guarantees that are customarily issued by the Bidder or manufacturer to the State of Utah.
 - c. UDOT, or their appointee, may elect to make minor repairs, with the consent of the manufacturer. Make all other repairs under warranty by the manufacturer. The manufacturer bears all costs including labor, parts, and shipping charges.
 - d. Replace or repair all LED Vehicle Traffic Signal Modules that exhibit luminous intensities less than the minimum values specified in **Article H-1a** within the first 60 months of the date of delivery.

2.9 ELECTRICAL CONDUIT

- A. Conduit and fittings:
 - 1. Schedule 40 PVC rated at 190 degrees F as specified. NEMA TC-2, TC-3. UL Listed.
 - 2. Rigid steel as specified. UL 6.
 - 3. Galvanized as specified. ANSI C80.1.
- B. Steel Casing:
 - 1. Provide smooth steel casing with a minimum 1/4-inch wall thickness and diameter as specified.

2.10 VEHICLE DETECTION

- A. Refer to SL Series Standard Drawings.
- B. Video Detection:
 - 1. State-furnished video detection equipment as specified. Refer to UDOT Accepted Products List for approved manufacturers.

- C. Induction Loop Detection:
 - 1. PVC or preformed loops:
 - a. Use for presence detection, traffic queue detection, and dilemma zone detection.
 - 2. Saw Cut loops:
 - a. Use for presence detection, traffic queue detection, and dilemma zone detection.
 - b. Use circular loop saw or standard pavement saw. Square loops require corner cuts. Avoid saw angles greater than 45 degrees.
- D. Radar Detection:
 - 1. Use for dilemma zone detection for typical high-speed approaches, and advance signal warning systems.
 - 2. Use for vehicle counting.

2.11 LOOP SEALANT

- A. Refer to SL Series Standard Drawings.
- B. Traffic loop embedding sealant:
 - 1. Isophthalic, acid-based, unsaturated, polyester resin.
 - 2. With sufficient adhesion, strength, and flexibility to:
 - a. Withstand normal movement in asphaltic and concrete pavements
 - b. Protect the loop wire from moisture penetration, fracture and shear.
 - 3. Cured sealant resistant to motor oils, gasoline, anti-freeze solution, brake fluid, and de-icing chemicals.
 - 4. Meet the physical property requirements in Table 2.

Table 2

Traffic Loop Embedding Sealant		
Physical Properties	Test	
Shore D Hardness	ASTM D 2240	50-65
Specific Gravity		1.13 - 1.20
Styrene Monomer, percent		28 - 32
Viscosity: Pa·s	Brookfield Model LVF #3 Spindle @ 60 rpm	0.7-0.9
Gel Time	MEK Peroxide 46-709	11 - 15 minutes
Tensile Elongation, % @ Break	ASTM D 638	15 minimum
Pot life, minimum		5 minutes
Tensile Strength	ASTM D 638	1200 psi

2.12 LUMINAIRE

- A. General:
 - 1. Die-cast aluminum housing.
 - 2. Reflectors, sockets, mounting cradles, and clamps fitted to the upper housing.
 - 3. High temperature wiring.
 - 4. Luminaire weight and projected area within design loading limits.
 - 5. Refer to SL Series Standard Drawings.
- B. Ballast Assembly:
 - 1. Pre-wired on integral ballast with quick disconnect plugs mounted on a removable, hinged door.
 - 2. Multi-volt, multi-watt ballast.
 - 3. Provide correct ballast assembly for the specified lamp type:
 - a. High-pressure sodium.
 - b. Metal halide.
- C. Optical Assembly:
 - 1. Formed aluminum reflectors with a chemically bonded, non-breakable, glass finish on both the inside and outside surfaces.
- D. Mogul Base Socket:
 - 1. Adjustable with split-shell, tempered-brass lamp grips.
 - 2. Free-floating, spring loaded center contacts.
 - 3. Heat and impact-resistant glass prismatic refractors.
- E. Mounting Adjustment:
 - 1. Standard Highway Luminaire (Cobra Head):
 - a. Ten degrees above horizontal for the reflector and refractor.
 - b. Five degrees adjustment from vertical on the bracket arm.
- F. Lamp:
 - 1. High pressure sodium lamp as specified:
 - a. Clear uncoated lamp.
 - b. Apparent color temperature of 2100 K.
 - c. Rated-life of not less than 24,000 hours when used on a 10 hour per start duty cycle.
 - 2. Metal halide lamp as specified:
 - a. Clear uncoated, pulse start lamp.
 - b. Apparent color temperature of 3800 K.
 - c. Rated-life of not less than 20,000 hours (400 Watt) or 10,000 hours (250 Watt) when used on a 10 hour per start duty cycle.

2.13 GROUND ROD

- A. Copper-coated steel as specified.
- B. ANSI/UL 467.

2.14 MESSENGER CABLE

- A. 3/8 inch diameter galvanized, stranded steel cable.
- B. Minimum breaking strength of 10,800 lb as specified.
- C. ASTM A 123.

2.15 MOUNTING BANDS AND BUCKLES

- A. As specified.
- B. AISI Type 201.

2.16 POWER SOURCE

- A. Refer to SL Series Standard Drawings.
- B. Pole Mounted Service:
 - 1. NEMA wet service rated service enclosure.
 - 2. Provide a manual EUSERC approved circuit closing link by-pass release meter socket.
 - 3. Other requirements as specified and as required by the local power company. Provide a product consistent with specifications for Underground Service Pedestal.
- C. Underground Service Pedestal:
 - 1. Service Disconnect:
 - a. Provide pedestal rated for 100-amp, 1-Phase 3-wire 120/240v service.
 - b. Provide 200-amp utility landing lugs rated for 250 MCM wire.
 - c. Provide pedestal that is split into an “un-metered” and a “metered” side.
 - d. Provide plug in circuit breakers that are UL approved, industrial grade, and rated for 10K AIC minimum.

- e. Provide one double pole 70-amp main circuit breaker labeled “Metered Main” and one single pole 40-amp circuit breaker labeled “Traffic Signal” with minimum capacity for four metered single pole circuit breakers. Provide traffic signal circuit breaker that is secondary to the metered main breaker.
- f. Provide one double pole 50-amp main circuit breaker labeled “Un-metered Main” and one double pole 20-amp circuit breaker labeled “Lighting” with minimum capacity for four un-metered double-pole circuit breakers. Provide lighting circuit breaker that is secondary to the un-metered main circuit breaker.
- 2. Provide pedestal that is pre-wired according to NEC and NEMA Specification with UL approved copper XHHW-2 cable bussing, fully rated. Provide provisions for terminating to a ground rod.
- 3. Provide pedestal with UL 508 rating.
- 4. Provide self-standing NEMA 3R cabinet (direct burial pedestals are not acceptable) with gasket in place, fabricated of 0.120 inch minimum thickness anodized aluminum.
 - a. Provide all exterior components that are rustproof.
 - b. Provide exterior that has no exposed hardware except for handles.
- 5. Meet EUSERC requirements for all mounting hardware and installation details. Fit with EUSERC approved power meter base with manual link bypass.
- 6. Provide pedestal with service entrance, meter and distribution compartments with a corrosion resistant barrier to separate each compartment. Provide access panel or door with stainless steel piano hinges.
- 7. Provide cabinet with sealed window(s) of shatter resistant Lexan (or equivalent). Provide a meter that can be read from the front of the cabinet.
- 8. Provide documentation that is permanently and conveniently attached and includes the manufacturer’s name, address, phone number, a wiring diagram, date of manufacture, and all necessary information to order an identical pedestal and replacement parts.
- 9. Provide labels that are permanent (etched or engraved) and mechanically fastened to the cabinet. Label the front exterior of the cabinet “UDOT SIGNAL AND LIGHTING DISCONNECT.”

2.17 FLOWABLE FILL

- A. Refer to Section 03575.

2.18 HOT MIX ASPHALT

- A. Half-inch nominal. Refer to Section 02741.

2.19 MAST ARM SIGNS

- A. Provide sign fabricated from aluminum with Type III High Intensity sheeting (minimum). Refer to Section 02891.

PART 3 EXECUTION

3.1 PREPARATION

- A. Conform to the NEC.
- B. Coordinate State Furnished Materials:
 - 1. Pick up at the Department's Central Warehouse, 4501 South 2700 West, Salt Lake City, UT. Contact the warehouse to schedule a pickup.
 - 2. Pick up drop shipment materials at location specified.
- C. Do not disconnect or remove an existing signal system until the replacement system is functioning.
- D. Contact power company at least 30 days before the connection date, and verify the exact location, voltage, procedure, and materials required by the power company.
- E. Pothole, locate, and expose any utility that will conflict with drilling, trenching, or boring work associated with placement of signal/pedestrian poles and conduit.
- F. Reuse materials only as specified or as approved by the Engineer.

3.2 CONSTRUCT POLE FOUNDATION

- A. Refer to SL Series Standard Drawings.
- B. Concrete: AA(AE) required. Refer to Section 03055.
- C. Structural Concrete: Refer to Section 03310.
- D. Reinforcing Steel and Welded Wire: Refer to Section 03211.
- E. Do not weld reinforcing steel, anchor bolts, or conduit.
 - 1. Use tie wire to secure conduit.
 - 2. Use template to align and secure anchor bolts.

- F. Drilled Caisson: Refer to Section 02466. Place concrete directly in excavation. Use minimum forming above ground.

3.3 STEEL PLACEMENT

- A. Install poles plum (vertically straight).
- B. For signal poles, tighten anchor bolt nuts to snug-tight plus 1/3 turn.
- C. For poles with break-away slip base systems, tighten anchor bolt nuts as shown on SL Series Standard Drawings.
- D. Field assemble two-piece mast arm slip joint to achieve a snug fit. Apply anti-seize compound and provide overlap not less than 1.5 times inside diameter of end section.

3.4 TRENCHING AND DIRECTIONAL BORING FOR CONDUIT

- A. Trenching Paved Surface (asphalt concrete):
 - 1. Do not use backhoe.
 - 2. Make the trench 6-inches wide or less.
 - 3. Use flowable fill to within 3-inches of the existing roadway surface.
 - 4. Evenly apply tack coat before final backfill.
 - 5. Match the composition, density, and elevation ($\pm 3/16$ -inch) of the existing surface in the final 3-inches of backfill.
- B. Trenching Unpaved Surface:
 - 1. Use backfill that matches the composition, density, and elevation ($\pm 3/16$ -inch) of the existing surface.
 - 2. Install conduits that cross finished curbs and gutters, sidewalks, concrete flatwork, textured or decorative surfaces by jacking, drilling, or pushing. Entirely replace any damaged section at no additional cost to Department.
 - 3. Dispose of surplus material daily.
- C. Trenching under Railroad:
 - 1. As specified in railroad agreement.
- D. Minimum cover of conduit:
 - 1. Minimum cover for all roadway crossings: 24-inches for conduit placed in trench; and 36-inches for directional bore conduit.
 - 2. Minimum cover off roadway without concrete encasement or capping: 18-inches.
 - 3. Minimum cover off roadway with concrete encasement or capping with minimum thickness of 2-inches: 12-inches.

- D. Directional Boring:
 - 1. Directional boring is an approved alternative to trenching unless otherwise specified.

3.5 INSTALL CONDUIT

- A. Place all conduits in the same trench before surfacing.
- B. Use galvanized rigid steel conduit above ground. Use PVC conduit under ground.
- C. Seal uncapped conduit ends inside junction box with at least 2-inches of duct caulking or PVC cap.
- D. Install No. 14 AWG single conductor copper, type THHN pull wire in all unused/future-use conduit.
 - 1. On each end of conduit install cap with $\frac{7}{32}$ -inch hole for pull wire.
 - 2. Leave 20-inches of wire outside of the cap, fastened securely.
 - 3. Place future-use conduit in top portion of junction boxes for future access.
- E. Secure conduit on structures with standard galvanized iron conduit clamps using at least $\frac{5}{16}$ -inch diameter concrete expansion anchors at maximum 60-inch spacing.
- F. Use conduit expansion fittings at structure expansion joint crossings.

3.6 INSTALL WIRING

- A. Conductors:
 - 1. Clean and dry the inside of the conduit before installing conductors.
 - 2. Install grounding conductor in all power circuit conduits.
 - 3. Use powered soapstone, talc or other approved lubricants when pulling conductors in conduit.
 - 4. Tape the ends of unused conductors and label them as spares.
 - 5. Use conductors that are color coded as specified. See table 4. Meet IMSA 20-1.
- B. Bonding Conductor (Ground) Wire:
 - 1. Size bonding wire in conformance to NEC article 250. Run continuously and bond to each metal signal pole.
 - 2. Bond the grounding system conductor to the ground rod in each junction box except in circuits with less than 50 V.
- C. Arrange the wiring neatly within cabinets, junction boxes, fixtures, etc.
- D. Terminate all terminal connections by a mechanical (spade) connector.

- E. Loop Detection Wire Splicing:
1. Permit cable splices only in detection circuits where the wire type changes in the junction boxes. No other splices are allowed.
 - a. Strip insulation back on the ends of the shielded cable wires and all of the loop wires that are to be joined in series to allow a non-insulated butt splice to be crimped onto them with a $\frac{1}{8}$ -inch of copper extending past the end of the butt splice.
 - b. Strip loop ends as needed. Strip home run cable as needed and cut off the bare conductor drain wire. Use non-insulated butt splice connectors and crimp the loop leads to the home run leads then solder these connections.
 - c. Use an electric or butane soldering iron to solder the splices when all pairs have been joined as specified above so that solder covers the splice inside and out. Do not melt the insulation.
 - d. Wrap each soldered connection with black tape and mastic tape so that the non-insulated butt splices will not short circuit. Wrap entire splice with mastic tape then wrap the entire splice area with black tape. Be sure to overlap the outer sheaths on the home run and the loop leads by 1-inch. Apply waterproof sealant over the black tape and let dry.
 - e. Use a nylon tie wrap to secure the loop leads at the best location possible inside the pull box. Provide loop leads that are at least 48-inches long as measured from the top of the pull box to allow the Contractor to work on the splice above the box.
- F. Mark cabinet cables with colored vinyl electrical tape as specified in Table 3. Meet UL 510.

Table 3

Cables Marked with Colored Tape				
	Northbound P2	Southbound P3	Eastbound P4	Westbound P1
Signal Circuit	Blue	Red	Yellow	Orange
Detector Circuit	Blue	Red	Yellow	Orange
	Circuit Coding One band = Through, Two bands = Left Turn, Three bands = Queue, Four bands = Dilemma			
Pedestrian Head Circuit	Blue & Green	Red & Green	Yellow & Green	Orange & Green
Pedestrian Button Circuit (3)	Blue & White	Red & White	Yellow & White	Orange & White

- G. Connect conductors according to Table 4.

Table 4		
Color-Coded Conductors		
	North-South	East-West
Seven-Conductor Pedestrian Circuit	Red – Don't Walk Green -Walk White – Neutral	Black - Spare Orange – Don't Walk Blue - Walk White with Black Tracer - Neutral
Four -Conductor Pedestrian Head Circuit Push Button Circuit	Red – Pedestrian Call White - Common	Black - Pedestrian Call White - Common
Seven-Conductor Signal Circuit	White – Neutral Red - Red Through Orange - Yellow Through Green - Green Through Blue - Green Arrow White with Black Tracer - Yellow Left Black - Left red or spare	

3.7 INSTALL DETECTOR LOOPS

- A. Refer to SL Series Standard Drawings.
- B. One turn is once around the perimeter of the loop with the same conductor.
1. Use number of turns as specified in Table 1 (Loop Resistance Table).
 2. Do not allow twists in the loop.
 3. No splices are allowed in loop
- C. Loop lead-in from loop to junction box:
1. Minimum of 3 twists per foot in saw cut.
 2. Minimum of 6 twists per foot inside of conduit.
 3. Do not interweave with other loop lead-ins.
 4. Each lead-in requires a separate conduit.
- D. For Detector Lead-in (feeder) from the junction box to controller cabinet, carry shield continuity across all splices.
- E. Saw cut loop:
1. Only circular loops may be saw cut into existing surfaces.
 2. Remove all loose material and wash and dry all saw cuts.
 3. Place all loop wire in a ¼-inch polyethylene tube.

4. Seat the conductor with no damage at the bottom of the slot. Place 1-inch backer rod pieces 18-inches along saw slot to prevent loop wires from floating upward in sealant.
 5. Fill the saw cut with embedding sealant; surround the polyethylene tube to the level of the existing roadway surface. Remove any excess embedding sealant.
- F. Preformed loop:
1. Trench 6-inch maximum width with 6-inch minimum to 12-inch maximum cover, in order to place loops below the pavement section.
 2. Include an additional turn in loops that are more than 8 inches below finished surface to compensate for reduced sensitivity.
 3. Anchor sensor loops to prevent movement or floating.
 4. Apply a tack coat to the sides and the bottom of trench and backfill with hot mix asphalt, ½ -inch nominal aggregate mix for loops trenched under existing asphalt. Refer to Sections 02741 and 02748. Compact with flat nose on a jack hammer in 3-inch maximum lifts.
 5. Preform and place loops under new pavement 1 ¾-inches below the surface of the base course and backfill with surrounding material.

3.8 INSTALL POWER SOURCE

- A. Verify the exact location, voltage, procedure, and materials required by the power company.
- B. Refer to SL Series Standard Drawings.

3.9 INSTALL LUMINAIRE

- A. As specified.
- B. Refer to SL Series Standard Drawings.

3.10 INSTALL SIGNAL HEAD

- A. Refer to SL Series Standard Drawings.
- B. Do not install signal heads at the intersection until ready for operation.
- C. Completely cover the vehicle signal heads with orange non-transparent, plastic garbage bags tied securely around the signal head if turn on is not immediate. New signal heads must not block active existing signals prior to new signal turn on.

- D. Install optically-programmed signal heads in accordance with the manufacturers instructions.
- E. Use louvered back plates on all signal heads except Type V.
- F. Use cable straps for all universal signal mounts.

3.11 INSTALL MAST ARM SIGNS

- A. Attach mast arm sign with mounting brackets using stainless steel straps. Do not drill holes in poles except as shown on the plans.
- B. Mount sign on mast arm so that the legend/message is horizontal, even if on a curved section of mast arm.

3.12 REMOVE AND SALVAGE EXISTING EQUIPMENT

- A. Light poles, signal poles, messenger cable, signal and pedestrian heads, controller cabinets, other items as specified on the plans remain the property of the Department.
- B. Transport items to the specified location.
- C. Remove foundations to a depth of at least 6-inches below the existing surface.
- D. Backfill all holes with local material and compact to the density of the surrounding area.

3.13 INSTALL VIDEO DETECTION

- A. Install all video detection components in accordance with the manufacturer specifications.
- B. Mount each video detection camera on the signal mast arm using the State-Furnished 46-inch extension pole and mounting bracket. Refer to SL Series Standard Drawings for camera placement mount.
- C. Install video detection cameras under the direction and supervision of UDOT staff, as specified. Provide a fully functional detection system.

END OF SECTION